LOAD CARRIAGE OF HEAVY MASSES

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ERGONOMICS TECHNOLOGIES

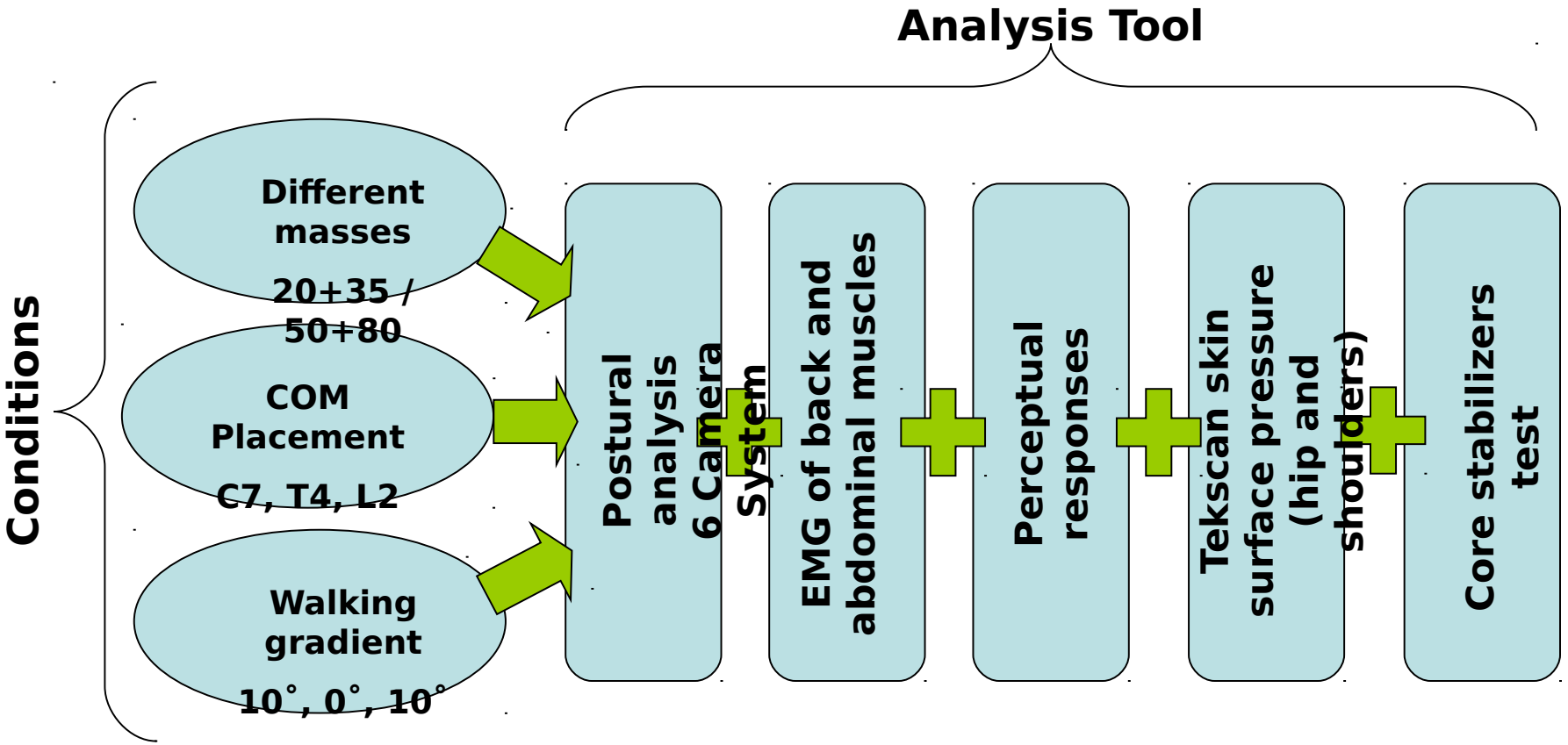
Objective:

- Report on four of the studies conducted for the load carriage research programme
- Study objectives were to provide specific inputs to pack specification on the African Warrior soldier pack
- Address pack design:
  - Placement of COM of pack to person
  - Pack design effect on soldier performance and user perceptions

Background:

- Previous load carriage work from physiological perspective
- Result in upper limit of 35kg mass
- Required operational items, hydration and food often exceeded mass
- Discussion of pack design for optimal COM placement
- Discussion of frame type
- OHS

Methodology: Laboratory studies



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Methodology: Field study

Mobility performance on the STMT and a route march, N = 30

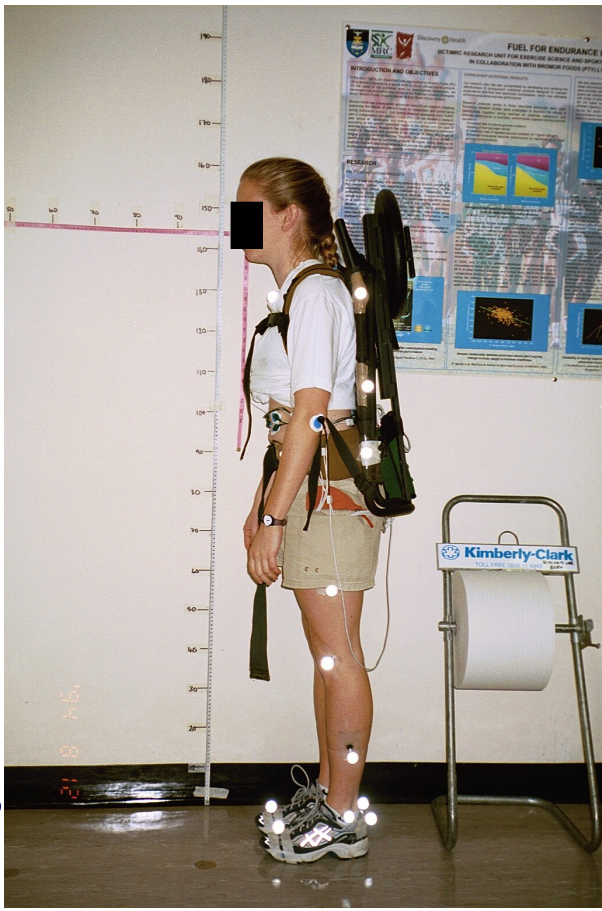
- One control, three experimental packs worn over a battle jacket
- Times were recorded for the STMT
- Perceptual responses for the route march
- Skin surface pressures- shoulder and hip strap

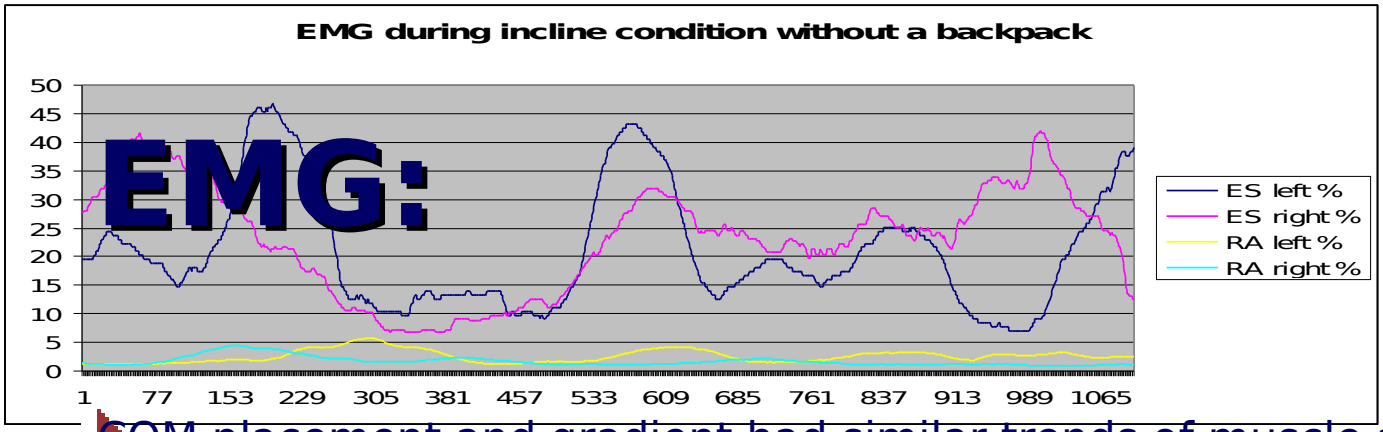
Methodology: End user perceptual survey

- Perceptual survey of pack components
- N = 45
- Focus group
  - facilitators
  - translators

RESULTS: Dynamic Postural Analysis

- Trunk lean angles
  - H/M COM >unloaded walking
  - L COM closer to unloaded walking
  - Higher the mass the greater the trunk lean angle
  - 50kg&80kg had similar trunk lean angles with limit of 40º
- Knee flexion angles < with > of mass
- Postural adjustment to mass & COM through knees then trunk, then ankles
- “Stiff legged gait”





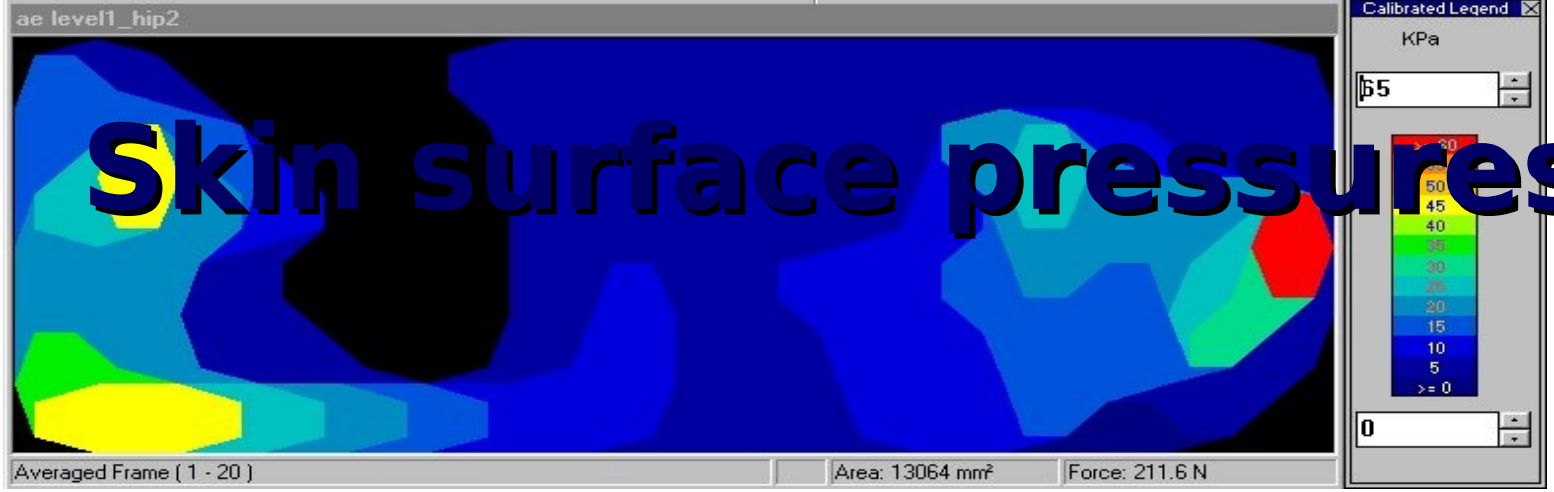
EMG:

- COM placement and gradient had similar trends of muscle activity
- Most stressful of **all** conditions for back and stomach = Low COM
- Least stressful for level gradient = Middle COM
- ..for incline & decline gradient = High COM

Core stabilizers test:

- Weak correlation with ability to lift loads
- N = 12
- Does not necessarily confirm protection of soldier

Skin surface pressures:

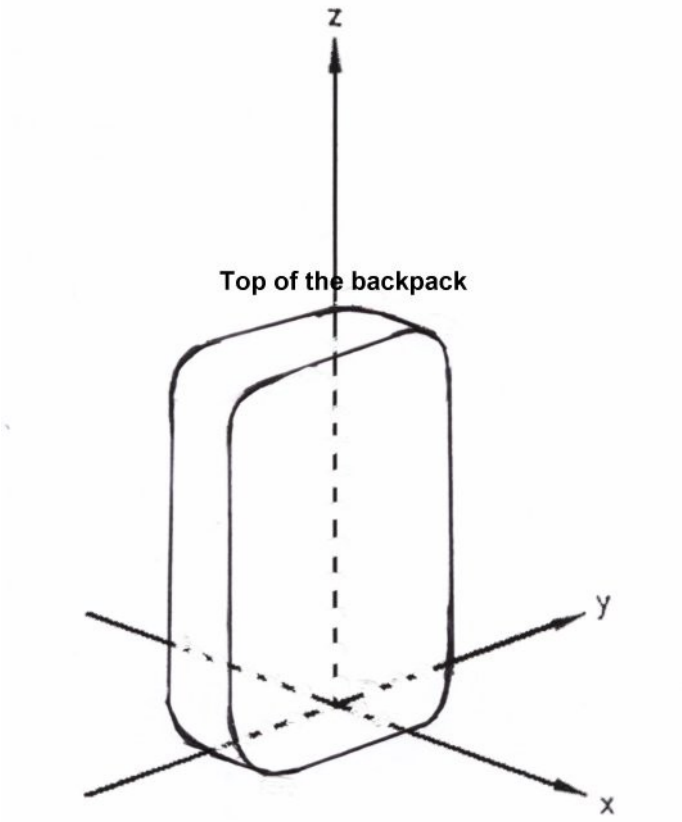


- Self adjusted – shoulders >hips
- Hot spots with square edges…
  - Bony aspect of shoulders and hips
  - Shoulder bulk
- Strap design critical to pressure distribution

Perceptual responses:

- Low COM rated consistently high/easiest for all conditions
- High & Middle COM rated the same for all conditions
- But…..reports of instability with the High COM
- Strain rating increases with mass increases
- Body Discomfort
  - 25/35kg: shoulders>backs
  - 50/80kg: Shoulders>lower legs

Placement of COM:



- Optimal placement T4, centred on spine
- LOW least acceptable
- High &Middle similar, but instability with High.

Performance trials:

- Total STMT times not significantly effected by pack
- Balance tasks better with internal frame with mass
- Route march better with external frame
- Control pack with least acceptable

End user perceptual survey:

- Poor use of hip belts
- Interface with battle jacket and pack critical
- Preference for external frame
- Preference for metal not plastic fastenings
- Requirement for packing volume for water

Conclusions:

- Heavy mass is a heavy mass
- Upper back at T4 between the shoulder blades, centered for the COG mass for heavy masses on all gradients
- Pack design is critical to posture, skin surface pressure and muscle fatigue
- User comfort contributes to acceptance of pack
- Prevalent resistance to using hip belts due to quick doffing requirement

Recommendations

- Pack design to facilitate optimal COM
- Payload mass >30kg use external frame
- Strap design & interface with battle jacket to decrease skin surface pressure
- Doffing times and use of hip belts, packing configurations in doctrine
- Further investigation into core stabilizing protection by conditioning programmes

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